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Research paper

Levels of serum copper and zinc in healthy adults from the west of Algeria

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Abstract

Essential trace element include zinc (Zn) and copper (Cu) are essential elements that play an important role in the whole-body metabolism. They have been implicated to play important roles in immuno-physiologic functions. The concentration of these elements in human organism varies widely between geographical areas depending on its content in soil and plants, dietary intake, bioavailability and retention, mineral interactions and other factors. The aim of this study was to measure the alterations in serum trace element concentrations, including Zn and Cu in one hundred and fifteen healthy adults (fifty-two males and sixty-three females) living in the west of Algeria using differential pulse anodic stripping voltammetry (DPASV) on a hanging mercury drop electrode. The mean copper and zinc concentrations were 105.26±19.63 µg/dL and 79.44±10.28 µg/dL, respectively. Serum concentrations of these elements were in the same range as those found for populations of other European countries.

Keywords: *Copper; Zinc; Serum; DPASV; Healthy Adults.*

1. Introduction

The biological role of trace metals, especially serum zinc and serum copper in different physiologic and pathologic conditions has been extensively investigated in recent years (Turgut et al 2009). Zinc is one of the most abundant trace elements in the body (Tapiero et al 2003). It plays an important role in human growth; it has a recognized action on more than 300 enzymes, by participating in their structure or in their catalytic and regulatory actions (McCall et al 2000; Yousef et al 2002; Jansen et al 2009). Zinc deficiency has long been recognized as a role-playing in a number of physiological disorders, including dermatologic conditions such as eczema, acne, and psoriasis (Bae et al 2010; Ricketts et al 2010; Melinda et al 2010), growth retardation (Takeda et al 2009; Gaetke et al 2010); poor wound healing (Guo et al 2010; Tabatabai et al 2011). Zinc deficiency has been associated with chronic liver disease, cirrhosis and chronic viral hepatitis (Poo et al 1995). The levels reduced zinc showed an inverse correlation with the degree of liver damage (Rocchi et al 1994; Gür et al 1998), liver fibrosis (Barry et al 1990), and markers of liver dysfunction such as bilirubin, albumin, and cholesterol (Pramoolsinsap et al 1994; Goode et al 1990). Serum zinc levels have also been noted in patients with alcoholic cirrhosis (Aaseth et al 1986; Ijuin 1998). Copper is one of several essential trace metals that are important in supporting biological functions for the human organism, forming part of many copper dependent enzymes and proteins joined to copper (O'Halloran et al 2000; La Fontaine et al 2002). Though the majority of the body's copper is in the Cu (II+) form, in the human body copper shifts between the cuprous Cu (I+) and cupric Cu (II+) forms (Linder et al 1996; Jack et al 2009). Like other transition metals, the ability of Copper to easily accept and donate electrons explains its important role in oxidation-reduction reactions and free radicals from the organism (Lobo et al 2010). Copper is necessary in human nutrition for normal iron metabolism and the formation of red blood cells (Angelova et al 2011). Copper deficiency is an increasingly recognized cause of neurologic degeneration and is also an established cause of anemia and the myelodysplastic syndrome (Kumar et al 2004). Acquired copper deficiency is also thought to affect cardiovascular and bone health (Relling 2007) weakness, fatigue, skin sores, poor thyroid function (Araya et al 2006) and low body temperature (Bonham et al 2002). Both Cu and Zn constitute integral important parts of certain enzymes such as superoxide dismatase, lycyloxidase and ceruloplasmin, which protect cells from oxidative degradation (Malave et al 1990). Copper and Zinc are known to be essential and the blood levels depend on certain factors such as, age, sex, physiological and pathological conditions (HO 2004). Establishing the normal range of trace element levels in the serum of healthy individuals in a geographical area is of value to form a reference range for further studies in the region. The differential pulse anodic stripping voltammetry (DPASV) on a hanging mercury drop electrode is a good method for the determination of trace amount of metals in biological samples. The aim of the present study is to introduce DPASV method for the determination of Copper and Zinc in serum of healthy adults.

2. Materials and methods

2.1. Equipment

Anodic stripping voltammetry measurements were performed using a commercially available polarography system POL 150 potentiostat linked to a polarographic stand MDE 150 and monitored by the Trace master 5 software. For the measurements with the polarograph, we used an Ag/AgCl (3 M KCl) reference electrode and a platinum auxiliary electrode, the working hanging mercury drop electrode (HMDE) was renewed prior to each measurement (delivered by Radiometer Analytical S.A, France). A 10 mL sample solution of support electrolyte was transferred to the voltammetric cell and purged with nitrogen for 5 min. The standard addition method was used to calculate ion concentration of copper and zinc in the sample solution. The operatory conditions for determination of copper and zinc have been optimized by attar et al (Attar et al 2012 and 2013).

2.2. Procedure

Ten milliliters of the supporting electrolyte solution were pipetted into the cell and deoxygenated with argon for 5 min. The accumulation potential - 1150 mV was applied to a fresh mercury drop while the solution was stirred. Following the accumulation period, the stirring was stopped and after 5 s the voltammogram was recorded by applying a positive potential scan at 20 mV/s. All data were obtained at room temperature.

2.3. Reagents

Aqueous solutions were prepared by dissolving a certain amount of chemicals into high-purity deionized water. Acids used for the analysis are the perchloric acid (70-72%, Merck) and the nitric acid (69.5%, Fluka). Stock solutions of zinc and copper (1000 mg/L) were purchased from Aldrich (atomic adsorption standard, Aldrich).

2.4. Digestion

A 0.5 mL of serum blood in a long-necked 50 mL flask, in which was added 2.0 mL of acid mixture (1.5 mL HNO_3 and 0.5 mL $HClO_4$) (Attar 2019). The temperature is maintained to 150°C during 4 hours and then the temperature is fixed at 200°C until quasi total evaporation of the contents. After cooling, we add the same mixture of acids to the residue, then we let evaporate until obtaining a dry residue (Attar et al 2013). After digestion, this residue is taken again by 5 mL of nitric acid at 0.25% and preserved in polyethylene tubes. Two duplicated digestions were performed for each sample.

3. Results and discussion

The accuracy of the method was evaluated by recovery tests. Mean recoveries for the added samples were 103.5 % and 101.7 % for copper and zinc, respectively. The accuracy and precision of the method used were tested in 10 replicate tests with a reference materiel (Seronorm Trace Elements Serum, Billingstad, Norway). The relative standard deviations (RSD) for copper and zinc in the range of the samples analyzed in this study were more than 3 and 5%, respectively. Because of the high sensitivity of the differential pulse anodic stripping voltammetry, this method is applied to the determination of Copper and Zinc in the serum.
A total of One hundred fifteen subjects (52 males and 63 females) of healthy adults Algerian volunteers were selected in this study. The mean serum copper and zinc concentrations for the healthy adults were 105.26±19.63 μg/dL and 79.44±10.28 μg/dL respectively (Table 1). The copper concentration range from 72.13 μg/dL to 155.27 μg/dL and the concentration of zinc was in the range from 53.70 μg/dL to 121.65 μg/dL in the most of all subjects.

Table 1: The Results of Means Copper and Zinc Concentrations, S.D.S, Range, and 95% Confidence Intervals

	Copper	Zinc
Mean (μg/dL)	105.26 ± 19.63	79.44 ± 10.28
Range (μg/dL)	72.13 - 155.27	53.70 - 121.65
Confidence 95%	98.80 - 111.74	77.59 - 81.36

No significant differences were observed, for both copper and zinc in serum concentrations after applying to them the Student's t-test. The mean serum copper concentration for the overall samples in the present study was lower than data published of a population Spanish (110.00±25.00 μg/L) by Romero et al 2002 and comparing to a Germany study (104.00±27.00 μg/dL) (Rukgauer et al 1997) it was nearly similar to our results. While, the comparison between the mean serum zinc concentration, for the overall samples (79.44±10.28 μg/dL) in the present study, with that of healthy subjects from various countries showed that the mean serum zinc in this study was nearly similar to the mean serum zinc values in healthy subjects of an Greek study (77.11±17.67 μg/dL) (Kouremenou-Dona et al 2006) and an Turkey study (81.65±16.40 μg/dL) (Vural et al 2000).

4. Conclusion

The evaluation of the serum status of Copper and Zinc in healthy adults living in the west of Algeria by using differential pulse anodic stripping voltammetry was performed for the first time in this study and in general, the results of this study agree with previously reported values from different countries.

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